Unlabored system motion by specially conditioned electromagnetic fields in higher dimensional realms

H. David Froning[a] and Gregory V. Meholic[b]

[a] *PO Box 1211*
Malibu, CA 90262
froning@infomagic.net
[b] *3631 Berryman Avenue*
Los Angeles, CA 90066
310-422-9726; orionstar2209@yahoo.com

Abstract. This third of three papers explores the possibility of swift, stress-less system transitions between slower-than-light and faster-than-light speeds with negligible net expenditure of system energetics. The previous papers derived a realm of higher dimensionality than 4-D spacetime that enabled such unlabored motion; and showed that fields that could propel and guide systems on unlabored paths in the higher dimensional realm must be fields that have been conditioned to SU(2) (or higher) Lie group symmetry. This paper shows that the system's surrounding vacuum dielectric εμ within the higher dimensional realm's is a vector (not scalar) quantity with fixed magnitude $\varepsilon_0\mu_0$ and changing direction within the realm with changing system speed. Thus, $\varepsilon\mu$ generated by the system's EM field must remain tuned to vacuum $\varepsilon_0\mu_0$ in both magnitude and direction during swift, unlabored system transitions between slower and faster than light speeds. As a result, the system's changing path and speed is such that the magnitude of the higher dimensional realm's $\varepsilon_0\mu_0$ is not disturbed. And it is shown that a system's flight trajectories associated with its swift, unlabored transitions between zero and infinite speed can be represented by curved paths traced-out within the higher dimensional realm.

Keywords: Group velocity, phase velocity, A-vector potential, subluminal, superluminal, tachyon, tardyon, SU(2) group
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INTRODUCTION

This third of a three part investigation explores the seemingly bizarre possibility of flight systems undergoing swift, unlabored acceleration between slower than light (STL) and faster than light (FTL) speed without the expenditure of energetics and force. In this respect, systems can undergo force-less acceleration (dV/dt) between different speeds in 4-D spacetime if their momentum p, that is their mass m times their velocity V, remains unchanged. Here:

$$dp/dt = d(mV) = 0 = m\,dV/dt + Vdm/dt = 0; \quad or \quad dV/dt = -\,dm/dt\,(mV) \tag{1}$$

But even if such force-less acceleration occurs, unlabored motion is still not achieved. For swift acceleration, dV/dt requires enormous mass rate of change dm/dt, which requires enormous rates of energy consumption c^2dm/dt. Such enormous amounts of expended

energy must either be extracted from the system itself or its surrounding medium. In either case, large quantities of energy must be extracted, expended, dissipated and lost in the vastness of space, and further significant energy expenditure will be needed for the system's subsequent deceleration to slower speed.

Since the three spatial and one temporal dimension of 4-D spacetime do not allow sufficient freedom for a system to undergo acceleration without expenditure of energy or exertion of force, Froning and Meholic (2008) created a higher dimensional realm that enabled such unlabored motion by providing an additional degree of freedom and mode of being for momentum- and energy-conserving system transitions between STL and FTL speeds. 4-D spacetime was reduced to a 2-D *x-y* spacetime plane. This simplification suppressed the two spatial dimensions transverse to system motion along the distance coordinate *x* and multiplied elapsed time *t* by the speed of light *c* along a *y=ct* coordinate.

Figure 1 shows the *x-y* spacetime plane of existence that displays the spatio-temporal behavior of moving objects as perceived by observers at rest with respect to Earth. The *x* coordinate shows the perceived distance dx_0 traveled by a photon during one unit of time. The *y=ct* coordinate shows the identical distance dy_0 traveled by the photon at light speed during one unit of temporal experience dt_0. Figure 1 also shows a system's acceleration from zero to infinite speed relative to Earth as the rotation of a vector of constant magnitude dy_0 on the *x-y* plane. Here, the system's motion state can be defined as V_y/c, or the ratio of its space travel *dx* to its time travel *dy*.

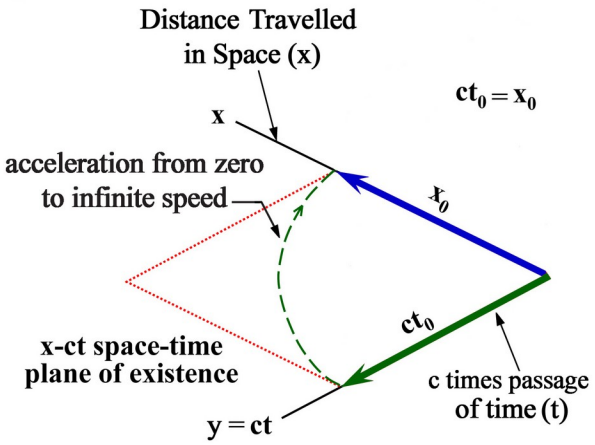

Figure 1. System acceleration from zero to infinite speed in an *x-y* spacetime realm of existence.

Much like distance x_o and time ct_o relationships can be made for a system, its momentum and energtics (*E/c*) can also be related. The ratio of a system's momentum to its energetics correlates to its *V/c*, which is also the ratio of system space travel *dx* to time travel *dy*. The system's *E/c* and *p* states are thus proportional to its *dx* and *dy* travel and can be viewed as pointing in the *x* and *y* directions. Thus, Figure 2 shows a photon's momentum p_o in the *x* direction being equal to its energetics E_0/c in the *y* direction (as would be perceived by observers at that are at rest with respect to the Earth).

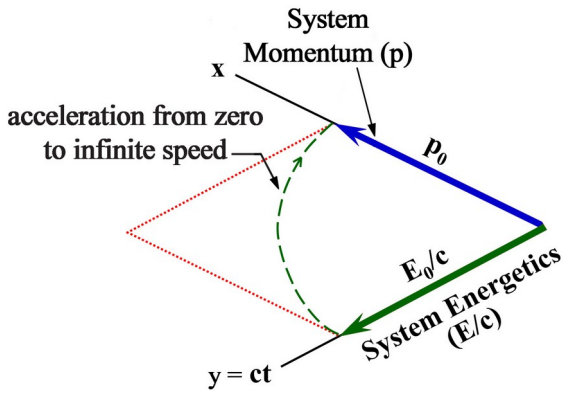

Figure 2. Conversion of system energetics into momentum during its acceleration in spacetime from zero to infinite speed.

Figure 2 also shows the system's labored acceleration from zero to infinite speed as rotation of a vector with constant magnitude E_0/c from a system's initial energetics state at zero speed to its final momentum state p_o at infinite speed. It also indicates the impossibility of undergoing unlabored acceleration between these speeds in spacetime. Even if the relativistic system mass-energy increase to stupendous values at nearly light-speed is avoided, system energy E_0/c at zero initial speed is not conserved (but reduced to zero at infinite speed). The system's initial zero momentum at zero speed is also not conserved (but increased from zero to p_o at infinite speed). Thus, the system undergoes labored acceleration in spacetime which requires expenditure of energy and exertion of force.

MOVEMENT IN HIGHER DIMENSIONAL REALM THAN SPACETIME

Because truly unlabored acceleration appears impossible in *x-y* Minkowski spacetime, a higher-dimensional realm of existence comprising of a complex, *x-y-iz* Minkowski space was created by Froning and Meholic (2007). This was done with a vertical coordinate *iz* that represents neither spatial nor temporal experience directly, but is assumed relatable to spatial and temporal experience unfolding along the *x* and *y* coordinates. Thus, just as temporal experience can be put in terms of distance by multiplying *t* by *ct*, so non-spatiotemporal experience τ unfolding along the *iz* coordinate is put in terms of distance by multiplying τ by an appropriate constant *k*. Figure 3 shows the higher dimensional *x-ct-ikτ* realm, wherein a given distance of space travel x_0 taking place along the *x* coordinate is set equal to both a given amount of time travel ct_0 along the *y* coordinate and to a given amount of τ travel $k\tau_0$ unfolding along the *iz* coordinate. However, Figure 3 shows only one of four possible quadrants of activity that is possible in the *x-y-iz* realm. A system's space travel can be either "forward" or "backward" and its τ travel can be either "up" or "down". And, if there can be time travel from "now" to the "past", four more quadrants will exist in the *x-y-iz* realm.

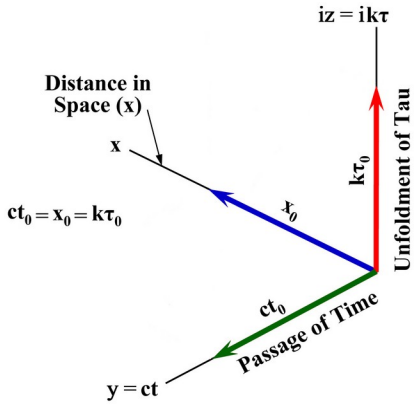

Figure 3. Identical amounts of system space, time and tau travel in a higher dimensional *x-y-iz* realm.

A system's *E/c* and *p* are proportional to its *dx* and *dy* travel and viewed in Figure 3 as pointing in the *x* and *y* directions. And just as Figure 3 shows a given τ experience $k\tau_0$ unfolded in the *iz* direction equal to a given distance x_0 traveled in the *x* direction, so Figure 4 shows a given state of being iq_0 that is developed by a system in the *iz* direction being equal to a given system momentum state p_o that is developed in the *x* direction.

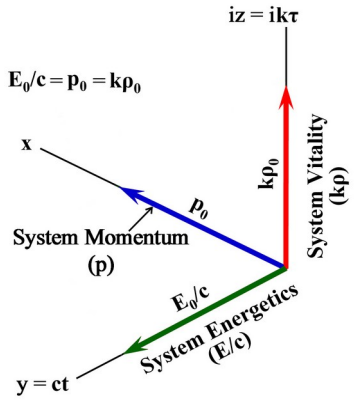

Figure 4. Identical magnitudes of system energetics in the *x, y* and *iz* directions of the higher dimensional *x-y-iz* realm.

LIGHT SPEED AND SPECIAL RELATIVITY IN A HIGHER DIMENSIONAL REALM

Just as Special Relativity requires light speed to be the same to all observers in an *x-y* Minkowski space, the same holds true to all observers in complex *x-y-iz* Minkowski space. This same magnitude of light speed V_c in any direction θ in any *x-iz* plane in the deeper *x-y-iz* realm can be described by a unit vector V_c/c which is:

$$V_c/c = dx/dy + i\, dx/dz = V_y/c + V_z/c = \sin\theta + i\cos\theta = \sin(\tan^{-1}V_y/c) + i\cos(\tan^{-1}V_y/c) = |1| \quad (2)$$

Lorentz invariance and relativistic dilation must occur for observers in higher dimensional *x-y-iz* Minkowski space. In this realm, Lorentz transformations relate spatial and non-spatial perceptions of a moving system by observers *O* and *O'* in relative motion V_r/c (which is *dx/dr*) with respect to each other. They are of the general form:

$$x' = (1/\beta)[x - r(V_r/c)]; \qquad r' = (1/\beta)[r - x(V_r/c)] \quad (3)$$

x' and r' are perceived spatial and non-spatial intervals between a moving system and O'; x and r are perceived intervals between moving system and O; V_r/c is motion state dx/dr of O' relative to O; and β is $[1 - (V_r/c)^2]^{1/2}$. If observer O' is on the moving system, Equation (3) reduces to:

$$x' = x\,(1/\beta)\,; \qquad r' = r\,(1/\beta) \tag{4}$$

The non-spatial r and r' perceptions of observers O and O' in x-y Minkowski space are their sense of time passage y and y' (ct and ct') and motion state dx/dr of observer O' in the moving system relative to an observer O on Earth is dx/dy. Since dx/dy is also V_y/c, β becomes $[1-(V_y/c)^2]^{1/2}$. As a consequence, a singularity occurs if speed V_y equals c, and $1/\beta$ becomes infinite. Special Relativity forbids regions in x-y Minkowski space where dx/dr exceeds 1.0.

Non-spatial perceptions r and r' become $y+iz$ and $y'+iz'$ in x-y-iz Minkowski space, and $dx/(dy + idz)$ becomes $V_y/c(1+ idz/dy)^{-1}$. Thus, β becomes $[1- (V_y/c)^2\,(1+i\,dz/dy)^{-2}]^{1/2}$. This results in a singularity where $1/\beta$ is infinite if system speed V_y/c is $(1+idz/dy)$ relative to Earth in complex, x-y-iz Minkowski space. For a system and its onboard observer O' moving at motion state $(V_y/c)(1+i\,dz/dy)^{-1}$ relative to Earth observer O, Equation (3) becomes:

$$x' = x\,[1- (V_y/c)^2\,(1+i\,dz/dy)^{-2}]^{1/2}\,; \quad y' + iz' = (y + iz)\,[1- (V_y/c)^2\,(1+i\,dz/dy)^{-2}]^{1/2} \tag{5}$$

For observers at rest relative to Earth that have only x-y vision, dz/dy=0, iz'=0, and iz = 0. Equation (5) reduces to:

$$x' = x\,[1- (V_y/c)^2]^{1/2}\,; \qquad y' = y\,[1- (V_y/c)^2]^{1/2} \tag{6}$$

For observers at rest relative to Earth with only x-z vision: dy=0, y'= y = 0, and $V_z/c = dx/idz$. Equation (5) reduces to:

$$x' = x\,[1+ (dx/dz)^2]^{1/2}\,; \qquad z' = z\,[1+ (dx/dz)^2]^{1/2} \tag{7}$$

Figure 5 shows where Special Relativity forbids $dx/(dy+ix)$ values more than 1.0 in x-y and x-y-iz Minkowski space.

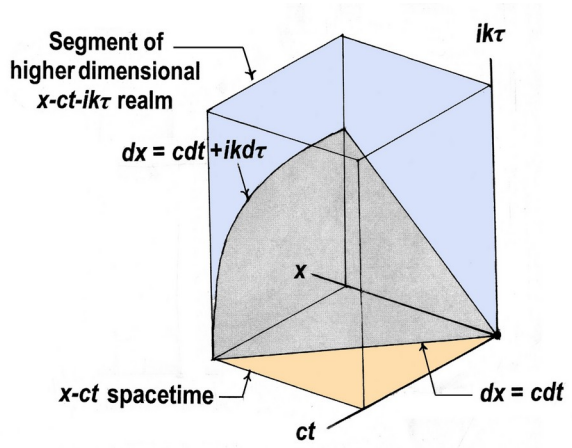

Figure 5. Regions forbidden by special relativity in x-y-iz Minkowski space.

SYSTEM MOMENTUM AND ENERGY CONSERVATION IN A HIGHER REALM

It is well known that adding a spatial dimension to a realm adds another translation and rotation degree of freedom to systems inside it. Thus, 1-D, 2-D, 3-D spatial realms endow two, four, and six total degrees of freedom (respectively) to systems within them. This results in more complex and coupled modes of system being. Our added iz dimension does not represent spatial extension, so it adds no actual volume of space to our x-y-iz realm. It does, however, represent an added experience that gives rise to an added degree of

freedom resulting in a more complex and coupled mode of system being within it. In this respect, the *iz* dimension provides possibility for a system's energetics being a complex quantity $(E_x/c+iE_z/c)$ in any *y-iz* plane in our higher dimensional realm. Here, E_x/c is energetics associated with the system's vibrational modes in *x-ct* spacetime, and iE_z/c (which is also *ikq*) is the system's energetics (its "vitality") associated with its non-vibratory modes in an orthogonal *x-iz* realm. Now, unlabored system accelerations between two speeds in the higher dimensional *x-y-iz* realm require conservation of system's energetics in any *y-iz* plane. This requires the magnitude of its $(E_x/c+ iE_z/c)$ be unchanged during its unlabored transitions between different speeds. This can be visualized as rotation of a constant magnitude state vector $(E_x/c+ iE_z/c)$ in any *y-iz* plane. Equation (8) (Froning, 2009) describes this energetics-conserving rotation in the higher dimensional *x-y-iz* realm in terms of the system's speed V_y relative to Earth; and the magnitude E_0/c of its energetics when it is at rest on Earth. Thus:

$$E_x/c+ iE_z/c = E_0/c\,[\cos(\tan^{-1}V_y/c) + i\sin(\tan^{-1}V_y/c)]; \quad \text{in any y-iz plane} \tag{8}$$

Just as system energetics conservation during its unlabored transition between different speeds is rotation of system energetics vector $(E_x/c+ iE_z/c)$ in any *y-iz* plane of the *x-y-iz* realm, so system momentum conservation is rotation of system momentum vector (p_x+ip_z) in any *x-iz* plane of the *x-y-iz* realm. Here, p_x is associated with system motion state *dx/dy* and its vibratory modes; and ip_z is associated with the system's non-vibratory modes and motion state *dx/dz*. Therefore, unlabored, momentum conserving system accelerations in the higher dimensional *x-y-iz* realm are rotations of the unchanged magnitude p_0 of a system's momentum vector in any *x-iz* plane. They are described as:

$$p_x + ip_z = p_0\,[\sin(\tan^{-1}V_y/c) + i\cos(\tan^{-1}V_y/c)]; \quad \text{in any x-iz plane} \tag{9}$$

Figure 6 shows simultaneous upward rotation of a system's energetics vector $E_x/c+ iE_z/c$ and downward rotation of its momentum vector $p+ikq$ in the *x-y-iz* realm during the system's unlabored acceleration from zero to infinite speed. The constant magnitude E_0/c of the system's energetics vector is seen to rotate from the *y* to *iz* coordinate in a *y-iz* plane while the constant magnitude p_0 of the system's momentum vector (which is equal in magnitude to E_0/c) rotates from the *iz* to *x* coordinate in an *x-iz* plane. Also shown is the system's energetics and momentum state at a given speed V_y/c during its transition to infinite speed. This is indicated by the angle θ ($\tan^{-1} V_y/c$) that the system energy and momentum vectors have rotated through in *y-iz* and *x-iz* planes in the higher dimensional *x-y-iz* realm.

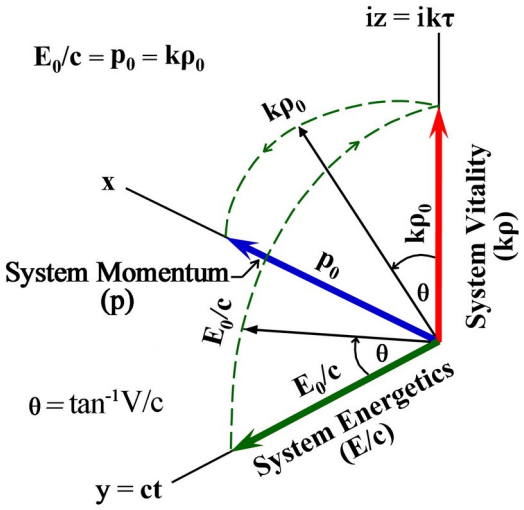

Figure 6. Rotation of system energetics and momentum vectors during unlabored acceleration from zero to infinite speed.

As mentioned, the energetics of a system moving in *x-y* spacetime can be viewed as a scalar quantity defining its internal energy associated with its vibrational modes, but the energetics of a system moving in a higher dimensional *x-y-iz* realm must be viewed as a vector-like quantity. In this case, the system's internal energy E_y/c in the y-direction is one component of E_0/c and system "vigor" iE_z/c in the z-direction (associated with its non-vibrational modes) is the other. If the system is undergoing unlabored acceleration, its E_0/c will rotate with constant magnitude in the higher dimensional realm. But both the system's internal energy and vigor will diminish with increasing system speed. Equation (8) shows that the system's energetics would also be perceived as $E_0/c[\cos(\tan^{-1}V/c)]$ to an observer in lower dimensional *x-y* spacetime with only *x-y* perception. The observer would see system energetics diminishing with increasing system speed V/c from its initial E_0/c value (at zero-speed) towards zero as it is perceived to approach infinite speed relative to Earth.

Similarly, momentum p_0 of a system moving in *x-y* spacetime is a single-component vector in the x-direction, while p_0 is a more complex two-component vector (with components p_y and ip_z) for a system moving in the *x-y-iz* higher dimensional realm. Momentum is conserved (i.e. remains constant in magnitude) for systems undergoing unlabored acceleration in the higher dimensional *x-y-iz* realm, but the system's momentum will be $p_0[\sin(\tan^{-1}V/c)]$ in lower dimensional *x-y* spacetime. Thus, observers with only *x-y* spacetime perception will see the system's momentum increasing from zero value (at zero speed) with increasing system speed until maximum momentum (which is equal to E_0/c) is reached as infinite system speed relative to Earth is reached.

SYSTEM STATES AND WORLDLINES IN HIGHER DIMENSIONAL REALMS

A moving system's "worldline" in *x-y* Minkowski space is the vector sum of its space travel *dx* and time travel *cdt*. In *x-y-iz* Minkowski space, the system worldline is the vector sum of its space travel *dx*, time travel $(dy=cdt)$, and τ travel $dz=kd\tau$. The system's energy-momentum state in *x-y* Minkowski space is the vector sum of its energetics E_x/c and momentum p_x vectors. In higher dimensional *x-y-iz* Minkowski space, the system's energy-momentum state is the vector sum of its energetics $(E_y/c+iE_z/c)$ in the *y* and *z* directions, and momentum (p_x+ip_z) in the *x* and *z* directions.

During unlabored system accelerations between very slow and very fast speeds, there can be periods of un-accelerated flight. Figure 7 shows system world lines, the paths traced out in *x-y-iz* Minkowski space, during a given interval of observation time t_0 on Earth. These paths are for constant velocity flight at zero speed, light speed and infinite speed relative to Earth. All paths are inclined 45 degrees relative to *x-y* spacetime and the total distance traveled on them at the different system speeds is the same even though directions of travel are different. The figure also shows that the paths for light and infinite system speed do not penetrate zones forbidden by Special Relativity.

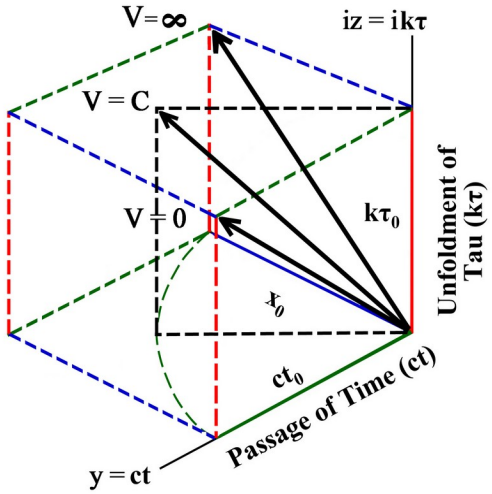

Figure 7. System **p**aths in *x-y-iz* Minkowski space at different speeds relative to earth.

For unlabored system acceleration from zero to infinite speed within the higher dimensional *x-y-iz* realm, Figure 8 shows a system's energics-momentum state (the vector sum of its energetics $[E_y/c+iE_z/c]$ and momentum $[p_x+i\ p_z]$ in *y-iz* and *x-iz* planes) at zero speed, light speed and infinite speed relative to Earth. All state vectors are identical in magnitude and inclined 45 degrees with respect to *x-y* spacetime, but point in different directions for the different speeds. So, although system energetics and linear momentum are conserved during unlabored system acceleration, some added angular action seems required. It is thus conceivable that 3-D modeling of space (rather than our 1-D) might reveal quantities such as angular momentum not to be conserved. If so, then perhaps the additional torques and forces needed for angular pointing could be supplied by propulsion and control systems of modest mass.

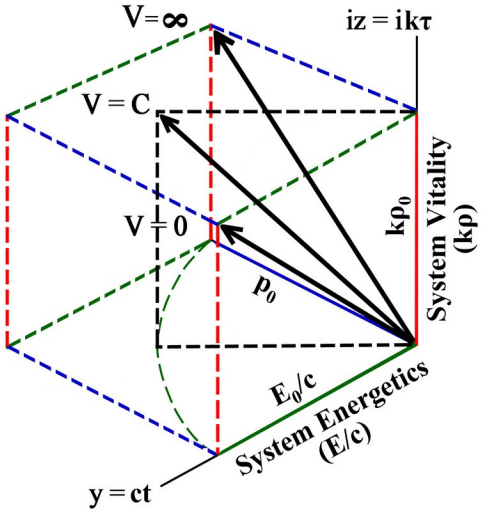

Figure 8. System dynamical states during unlabored flight at different speeds relative to earth.

PERTURBING VACUUM DIELECTRIC IN HIGHER DIMENSIONAL SPACE

Puthoff, Little and Ibsen (2002) show that field-generated "warping" of spacetime metric can be approximated by "perturbing vacuum dielectric" by changing the refractive index of

space. This would be done by perturbing the electrical permittivity ε and magnetic permeability μ of the undisturbed, "empty-space" in a system's vicinity. Here, the vacuum ε and μ within a given region of space determine light propagation speed c within it, and how the rest mass M_0, rest energy E_0 and tempo of time t_0 inside the system moves through it. From Puthoff, (2002):

$$V_c/c = [\varepsilon_0\mu_0 / \varepsilon\mu\ ]^{1/2}\ ;\ \ M_0 = M_{00}[\ \varepsilon\mu / \varepsilon_0\mu_0\ ]^{3/2};\ \ \ E_0 = E_{00}\ [\varepsilon\mu / \varepsilon_0\mu_0\ ]^{1/2};\ \ t_0 = t_{00}\ [\varepsilon\mu / \varepsilon_0\mu_0\ ]^{1/2} \qquad (10)$$

Here, $\varepsilon_0\mu_0$ is unperturbed vacuum dielectric, and $\varepsilon\mu$ is perturbed vacuum dielectric in close proximity to a system. Mass M_{00}; energy E_{00}; tempo of time t_{00} are a system's mass; energy; tempo of time when it is at rest on Earth.

It is assumed that the higher-dimensional *x-y-iz* realm will also possess an "empty-space" and vacuum dielectric, but it is expected to be more complex. Thus, $\varepsilon = [\varepsilon_y + i\varepsilon_z]$ and $\mu = [\mu_y + i\mu_z]$ in any *y-iz* plane in this realm. So:

$$[\ \varepsilon\mu\ ][\ \varepsilon_0\mu_0\ ]^{-1} = [(\varepsilon_y\mu_y - \varepsilon_z\mu_z) + i(\varepsilon_y\mu_z + \varepsilon_z\mu_y)][\ \varepsilon_0\mu_0\ ]^{-1} \qquad \textit{in any y-iz plane} \qquad (11)$$

Similarly, in any *x-iz* plane within the higher *x-y-iz* realm, ε and μ are complex quantities $(\varepsilon_x + i\varepsilon_z)$ and $(\mu_x + i\mu_z)$. So:

$$[\ \varepsilon\mu\ ][\ \varepsilon_0\mu_0\ ]^{-1} = [(\varepsilon_x\mu_y - \varepsilon_z\mu_z) + i(\varepsilon_x\mu_z + \varepsilon_z\mu_y)][\ \varepsilon_0\mu_0\ ]^{-1} \qquad \textit{in any x-iz plane} \qquad (12)$$

Swift, unlabored system acceleration along energetics and momentum-conserving trajectories in the higher *x-y-iz* realm requires that no perturbing of its vacuum dielectric occur along these momentum-conserving and energetics-conserving paths. System generated $\varepsilon\mu$ must therefore remain identical to the $\varepsilon_0\mu_0$ of the undisturbed vacuum in both magnitude and direction as its speed changes appropriately during its unlabored acceleration. This will all happen if:

$$[\ \varepsilon\mu\ ] = \varepsilon_0\mu_0\ [\cos(\tan^{-1}V_y/c) + i\sin(\tan^{-1}V_y/c)] \qquad \textit{in any y-iz plane} \qquad (13)$$

$$[\ \varepsilon\mu\ ] = \varepsilon_0\mu_0\ [\sin(\tan^{-1}V_y/c) - i\sin(\tan^{-1}V_y/c)] \qquad \textit{in any x-iz plane} \qquad (14)$$

Figure 9 shows the dielectric vector associated with ship EM field propulsion processes changing in the higher dimensional *x-y-iz* realm during unlabored ship acceleration from zero to infinite speed. This is seen to be a directional change (not magnitude) of the dielectric vector. Here, both magnitude and direction of ship dielectric must match that of undisturbed vacuum in order that the undisturbed vacuum not be perturbed by the moving ship and exert force on it. Figure 9 shows the required rotation of the magnitude $\varepsilon_0\mu_0$ of the ship dielectric vector in *y-iz* and *x-iz* planes in order to conserve energetics and momentum during unlabored ship acceleration from zero to infinite speed. Also shown is the change of the ship initial dielectric state $[(\varepsilon_r\mu_r)_1 + i(\varepsilon_i\mu_i)_1]$ at zero-speed to its final dielectric state $[(\varepsilon_r\mu_r)_2 + i(\varepsilon_i\mu_i)_2]$ at infinite speed relative to Earth. It may also be noted that $(\varepsilon_r\mu_r)$ and $i(\varepsilon_i\mu_i)$ diminish to zero at infinite ship speed.

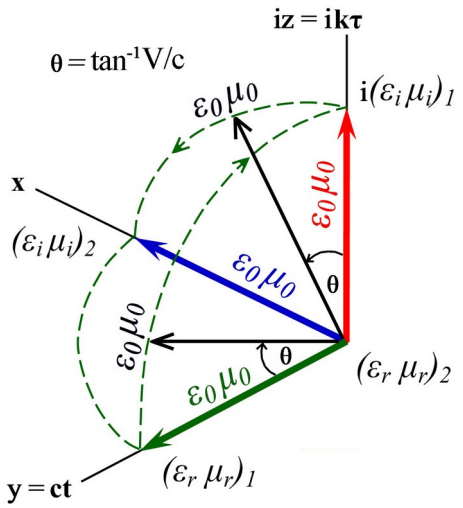

Figure 9. Required rotation of ship dielectric in *y-iz* and *x-iz* planes for unlabored acceleration from zero to infinite speed**.**

A system's dielectric state vector can be defined as the sum of the dielectric vectors that evolve in *y-iz* and *x-iz* planes in the *x-y-iz* realm. For a system undergoing unlabored acceleration, the dielectric vectors associated with its energetics conservation in *y-iz* planes and momentum conservation in *x-iz* planes is shown in Equations (13) and (14). Figure 10 shows ship dielectric state vectors for unlabored acceleration at zero speed, light speed and infinite speed relative to Earth. Like energy-momentum state vectors, ship dielectric state vectors are identical in magnitude and inclined 45 degrees with respect to *x-y* spacetime, but point in different directions for the different speeds.

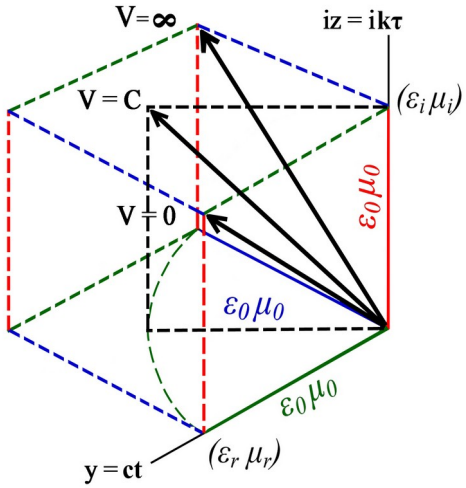

Figure 10. Required magnitude and direction of a system's dielectric state for different speeds.

Figure 10 has implications for the needed natures of the vacuum polarizing vacuum fields that must emanate from ships undergoing unlabored acceleration. Vacuum dielectric associated with fields generated inside the ships must be "tuned" to the undisturbed vacuum dielectric existing outside them. Thus, magnitude and direction of the vacuum dielectric vector inside a ship must match that of the ambient, undisturbed vacuum dielectric outside it. Maintaining such correspondence would not be easy since it would require EM field actions outside spacetime in the realm where ordinary EM field actions take place. In addition, field direction changes would be needed with every change in speed.

SPECIALLY CONDITIONED EM FIELDS IN HIGHER DIMENSIONAL REALMS

EM Fields that can impel and guide systems on unlabored paths in higher realms must have components that not only act in 4-D spacetime, but in directions that are orthogonal to it. Ordinary SU(1) EM fields possess no ability to expand beyond spacetime, but Barrett (2008) uses group, gauge and topology theory to derive specially conditioned SU(2) EM fields that act not only in time and 3-D space, but in an added orthogonal direction as well. Table 1 shows expanded Maxwell equations which describe the actions of specially conditioned SU(2) EM fields in accordance with Gauss's, Ampere's, and Faraday's Laws. SU(2) EM fields contain electric and magnetic field content like ordinary SU(1) EM fields, but also contain additional terms that involve the coupling of electric and magnetic fields with A-vector and scalar potential fields.

TABLE 1. Expanded Maxwell equations and Lorentz force equations for SU(2) electromagnetic fields.

Gauss's Law	$\nabla \bullet E = J_0 - i\,q\,(A \bullet E - E \bullet A)$
Ampere's Law	$\partial E / \partial t - \nabla x \boldsymbol{B} + \boldsymbol{J} + \boldsymbol{i\,q\,(A_0\,E - E\,A_0) - i\,q\,(A\,x\,B - E\,x\,A) = 0}$
Gauss's Law	$\nabla \bullet B + i\,q\,(A \bullet B - B \bullet A)$
Faraday's Law	$\nabla x \boldsymbol{B} + \partial \boldsymbol{B} / \partial \boldsymbol{t} + \boldsymbol{i\,q\,(A_0\,B - B\,A_0) - i\,q\,(A\,x\,B - B\,x\,A) = 0}$
Lorentz Force	$\boldsymbol{F = e\,[-(\nabla\,x\,A) + E] + e\,\upsilon\,x\,[B - \partial A / \partial t - \nabla \varphi]}$

Figure 11 shows a graphical representation of Expanded Maxwell Equations for SU(2) EM fields that develop and act in the higher dimensional *x-y-iz* realm in accordance with Faraday's Law. Magnetic *B* and electric *E* field development with distance and time occurs in spacetime's spatial *x* and temporal *ct* directions, while coupling of these fields with A-vector fields occurs along the *iz* direction of the higher dimensional *x-y-iz* realm. The higher Lie symmetry of SU(2) EM fields therefore gives these fields added degrees of freedom and connectivity to perturb vacuum dielectric in both *x-y* spacetime, and in the deeper dimensionality of the *x-y-iz* realm. A-vector fields in this higher realm are described by nonabelian algebra wherein certain vector identities are not zero.

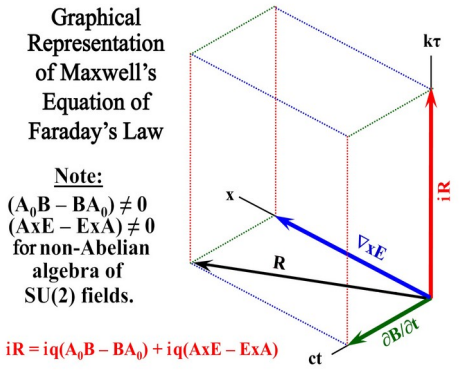

Figure 11. Graphical representation of Faraday-Law Maxwell equation for SU(2) EM field development in the *x-y-iz* realm.

Field impulsion and control of ships along unlabored accelerating paths in the higher dimensional realm require proper management of vacuum dielectric $\varepsilon\mu$ in the vicinity of the accelerating ships. In *x-y* space-time, ε is ratio of electric flux density to electric field intensity *D/E,* while μ is ratio of magnetic flux density to magnetic field intensity *B/H.* In the higher dimensional realm, ε is $(\varepsilon_y+i\varepsilon_z)$ and μ *is* $(\mu_y+i\mu_z)$ with ε_y and μ_y being the same as *D/E* and *B/H.* Flux density to field intensity ratios that $i\varepsilon_z$ and $i\mu_z$ correspond are not yet known, but are expected to be associated with dot and vector products of the A-vector field couplings with electric and magnetic fields.

EXAMPLES OF SPECIALLY CONDITIONED ELECTROMAGNET RADIATION

Figure 12 shows one way of generating specially conditioned SU(2) EM fields that could be propagated by laser, microwave, or radio-frequency beams. Here, phase and polarization modulation of ordinary EM radiation transforms it into specially conditioned SU(2) EM radiation by dividing a portion of input wave energy into an orthogonally polarized, phase-modulated component that combines at a mixer with remaining input wave energy and emitts EM wave energy that can undergo every possible polarization of its beam in less than one wavelength of beam travel.

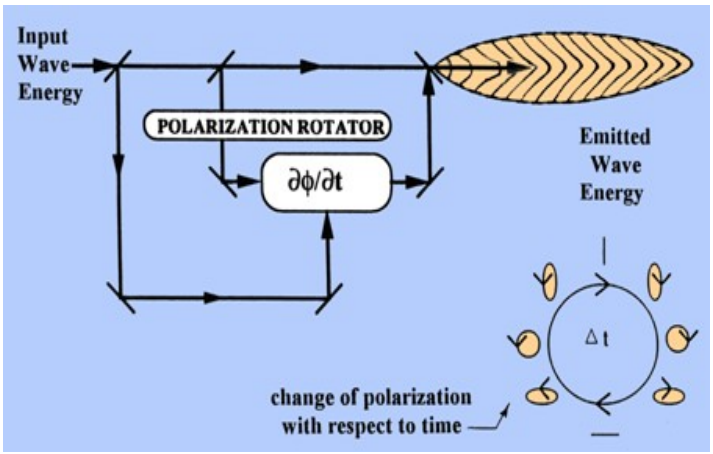

Figure 12. Creation of SU(2) EM radiation by phase and polarization modulation of a laser or microwave beam.

One benefit of phase and polarization modulation of EM beams is their improved propagation within the atmosphere of Earth. Less beam energy will be scattered or absorbed by air particles if its electric and magnetic fields vary in amplitude and direction (as shown in Figure 13) faster than the relaxation time of the matter that the beam excites.

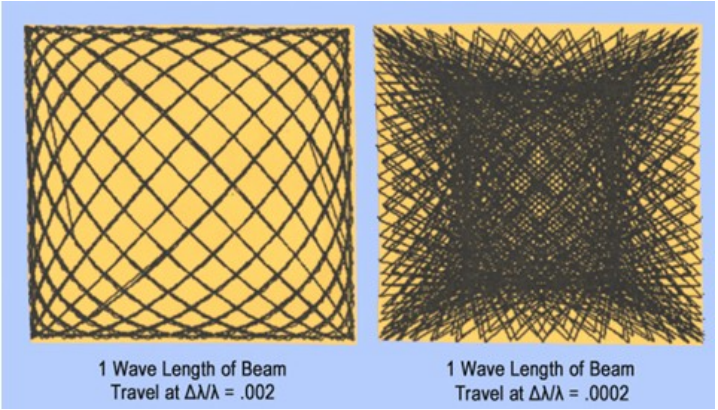

Figure 13. Multiple cycles of electric field vector rotation during a single wave length of SU(2) beam travel.

Barrett (1998) describes another way of generating SU(2) EM fields. By means of toroids with appropriate geometry, coil winding, and resonant frequencies, a single, SU(2) A-vector field is created that significantly increases toroid signal strength and range. Tests of toroids of various shape and configuration (Figure 14) revealed potentially significant results (Froning and Hathaway, 2001).

The notion also exists that EM fields of SU(2) or higher symmetry can also arise from actions such as coupling of spinning superconductors and magnetic fields, as described in Tajmar (2007), and from mass fluctuations created in capacitor dielectric material subjected to high voltage and frequency, as described in Woodward (2008).

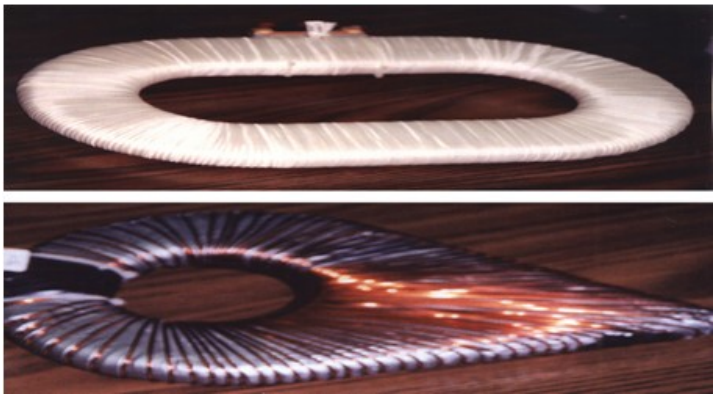

Figure 14. Asymmetric, caduceus-wound toroidal coils for SU(2) EM field generation at resonant radio frequencies.

SUMMARY AND CONCLUSIONS

Examples of universe theories like String or M-Theories can add as many as seven more dimensions to our 4-D world that supposedly give rise to the lower-order dynamics of all the particles and radiation observed within our material world. The added dimension of our higher dimensional realm, however, neither contains nor represents space or time. Rather,

it represents time-less, space-less experience that endows systems with the added degree of freedom and mode of being needed to undergo swift unlabored acceleration between the slowest and fastest possible speed.

This higher dimensional realm is, in effect, a complex Minkowski space that conforms to Special Relativity in terms of maintaining light speed invariant in all inertial frames and forbidding space travel to exceed travel in its other dimensions. Almost all possible trajectories in this higher dimensional realm are labored, requiring both expenditure of energetics and exertion of force. Nevertheless, the reaches of this realm contain no singularities that prevent light-speed being surpassed and infinite speed being reached. And within this higher dimensional realm there is a family of trajectories that accomplish swift, unlabored system accelerations between almost zero and almost infinite speed.

If the cosmos is actually of higher dimensionality than spactime and has unlabored paths within it, a way of guiding systems through this deeper realm and along its unlabored paths could be system-generated EM fields with needed gauge symmetry and connectivity to permeate this deeper realm and interact effectively with its vacuum dielectric.

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